Space Weather Technical Forecast

Issued on Wednesday, 14 September 2022 at 01:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storms days 1 and 3 (14th and 16th). M-class flares considered likely. Ongoing Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, but with a long period C9 flare observed around 13/1500 UTC from AR3098, which produced an unusually slow CME. There are four sunspot regions on the disk. AR3098 in the northwest quadrant remains the largest and most complex spot. AR3100, is elongated but only has one significant spot. The remaining significant region, AR3102 has rotated onto the southeast limb with a large leader and small trailing spot. The remaining region is small and simple. No new Earth-directed CMEs were evident in imagery. Though there remains a slight risk of a glancing blow from a CME which left the Sun on the 11th.

Solar Wind / Geomagnetic Activity: The solar wind speed at L1 has followed a declining trend, with winds at background levels. Density was below average. The total magnetic field strength was weak below 5nT, with the north-south component fluctuating between +4/-3 nT. Phi angle was entirely positive (away from the Sun). Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, reached 6.7 pfu at 12/1405 UTC before declining back to near background. This is likely due to the forecast effects of a filament eruption on 11 September.

High energy electron flux varied from moderate to high. The corresponding 24-hour electron fluence remained above Active (1e8 integrated pfu) with a generally flat trend, resulting in a 14/0000 UTC observed value of 2.15e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Further M-class flares are considered likely with a very slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: A CME which was observed leaving the Sun on 11 September may arrive at Earth on 14 September, although confidence is low. CH23/- may become geoeffective from midday day 3 (16th), perhaps bringing elevated solar wind speeds until the end of the period. Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, with Active intervals likely and a chance of G1/Minor Storms day 1 (14th) and later day 3 (16th), due to the risk of a CME arrival, then the arrival of the High Speed Stream from CH23/-, although the forecast is low confidence.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels, but with a slight chance of exceeding the threshold, due to AR3098.

The high energy (greater than 2 MeV) electron flux is currently fluctuating between High and Moderate levels. This trend is expected to continue to ease through the period, though the arrival of faster solar winds on the 16th may increase electron flux again. The corresponding 24-hour fluence is expected to see only a gradual decline at first in the period, but is Expected to

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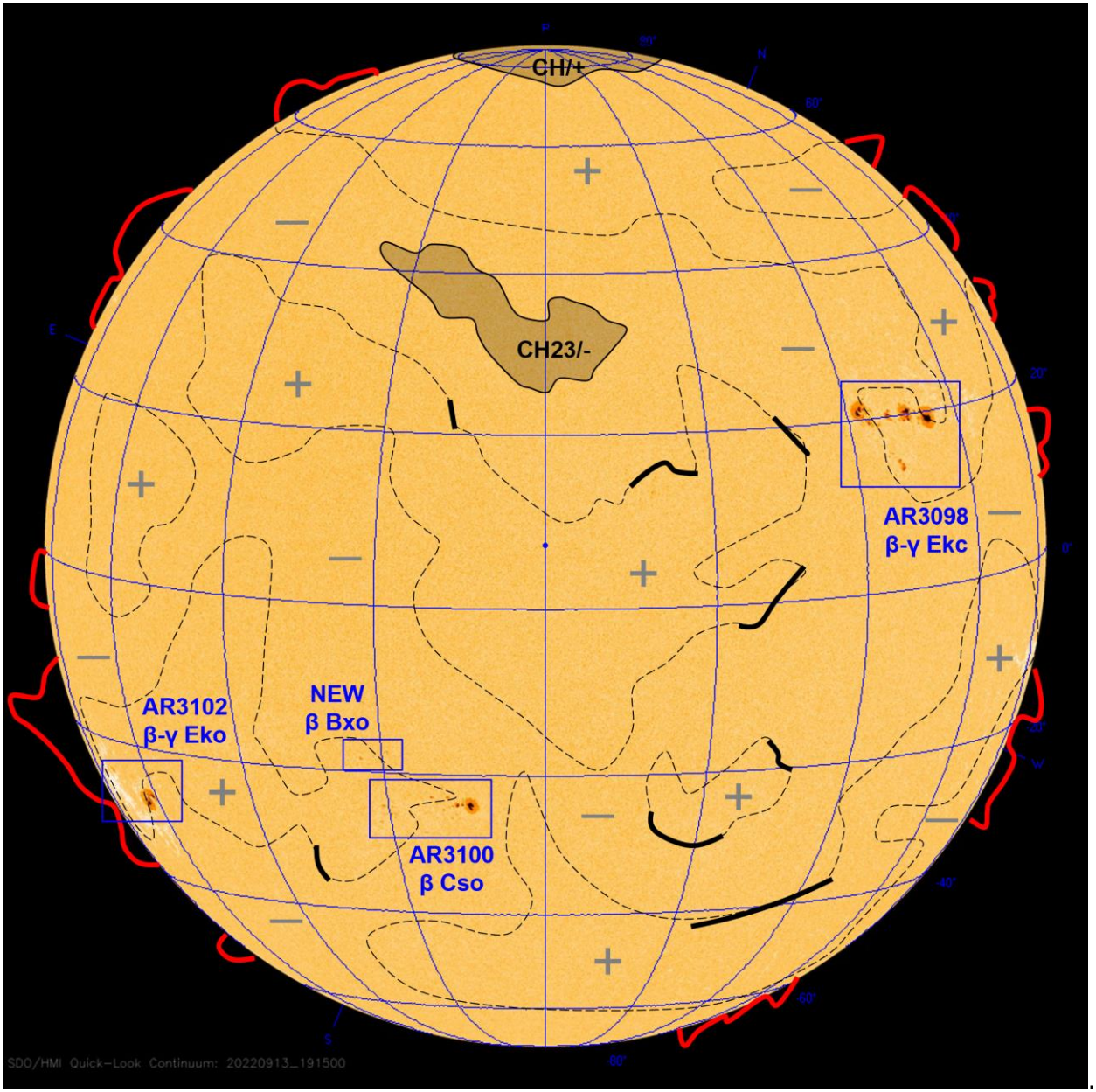
remain above Active (1e8 integrated pfu) until day 2 or 3 (15th or 16th).

Figure 1. Solar Analysis Valid 13/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

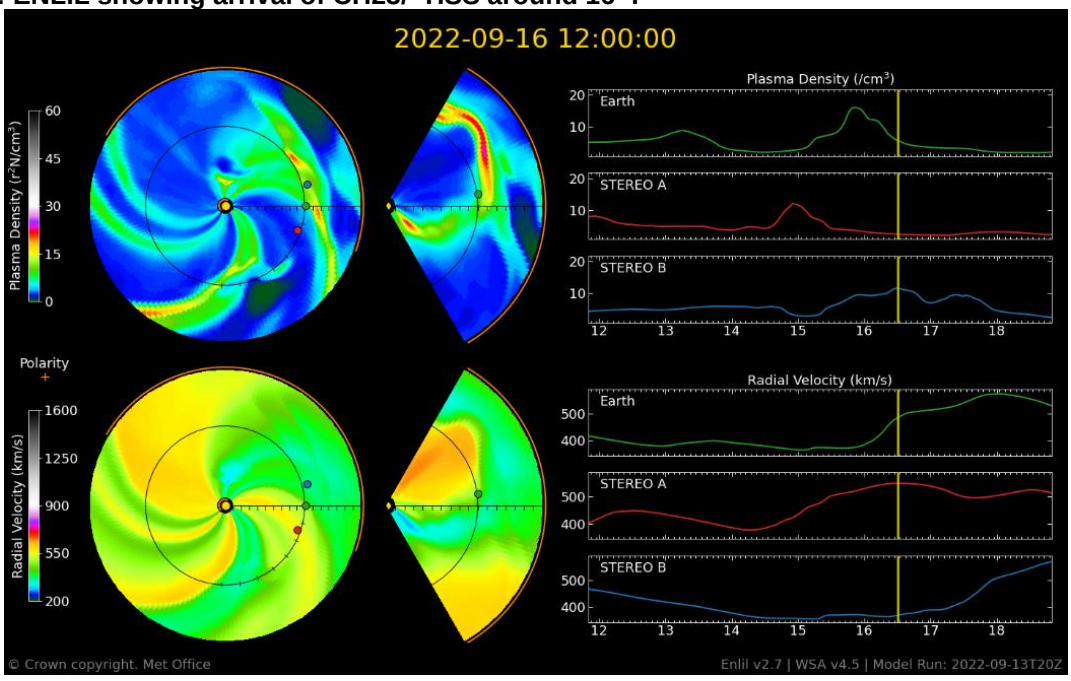
A filament eruption was observed leaving the north centre of the Sun around 11/1200UTC. STEREO A imagery although unclear indicates that a potentially Earth-directed CME has been emitted. The presumption of a CME however was supported by a sudden increase in the proton flux subsequent to the filament eruption, suggesting a 'snowplough' effect of proton enhancement ahead of a CME. In the absence of a sufficient analysis an estimate of a three day transit time would allow for an arrival during 14 September, with a risk of G1/Minor Storms, although the forecast of arrival time or potential impacts are low confidence.

The high speed stream from coronal hole 23 is then forecast to connect with Earth anytime from midday day 3 (16th), though due to its negative polarity as we approach the autumn equinox, significant geomagnetic enhancement is thought to be unlikely.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, with Active intervals likely and a chance of G1/Minor Storms day 1 (14th) and day 3 (16th), due to the risk of a CME arrival, then the arrival of CH23/-, although the forecast is low confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	30	20	30	20
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Figure 2: ENLIL showing arrival of CH23/- HSS around 16th.



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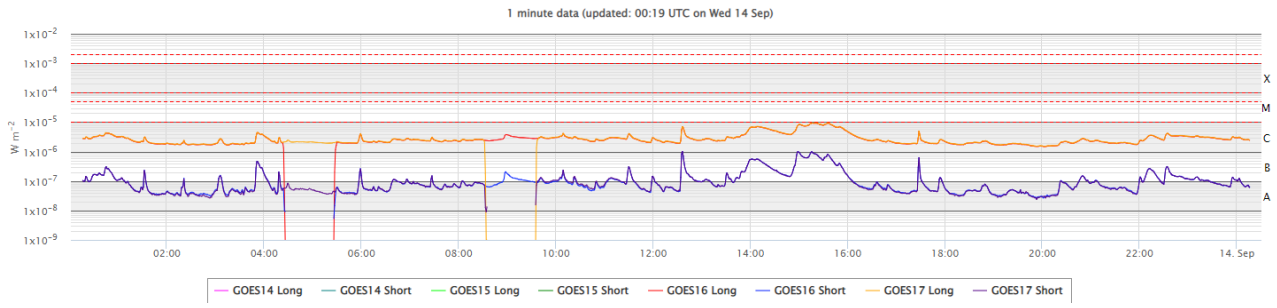
Radio Blackouts - X-Ray Flares:

The most significant sunspot region on the disc remains AR3098 (Ekc/βγ), this region produced an M1.7 flare at 12/2344 UTC, and a long period C9 flare around 13/1500 UTC. It may, however, have been responsible for a CME eruption on 11 September, so carries an enhanced flare risk. There are two other notable spots on the disk, AR3100 and AR3102, though neither are currently contributing with any moderate class flares. Further M-class flares are considered likely.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: 24 hur xray trace



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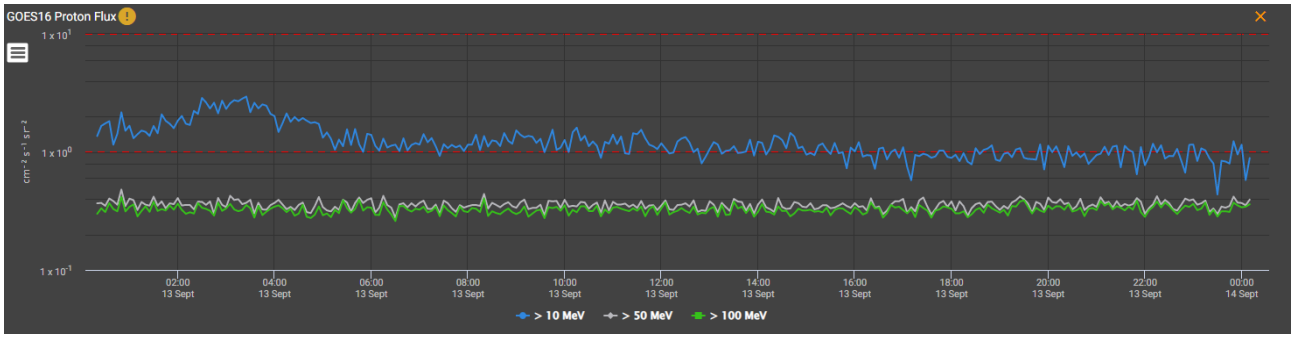
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) has undergone a marked decrease over the last 24 hours and is returning towards background levels. There is a slight chance that due to the location of AR3098, should a substantial flare and CME erupt from the spot, an increase in proton levels may rise above S1 Storm.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour Proton trace.



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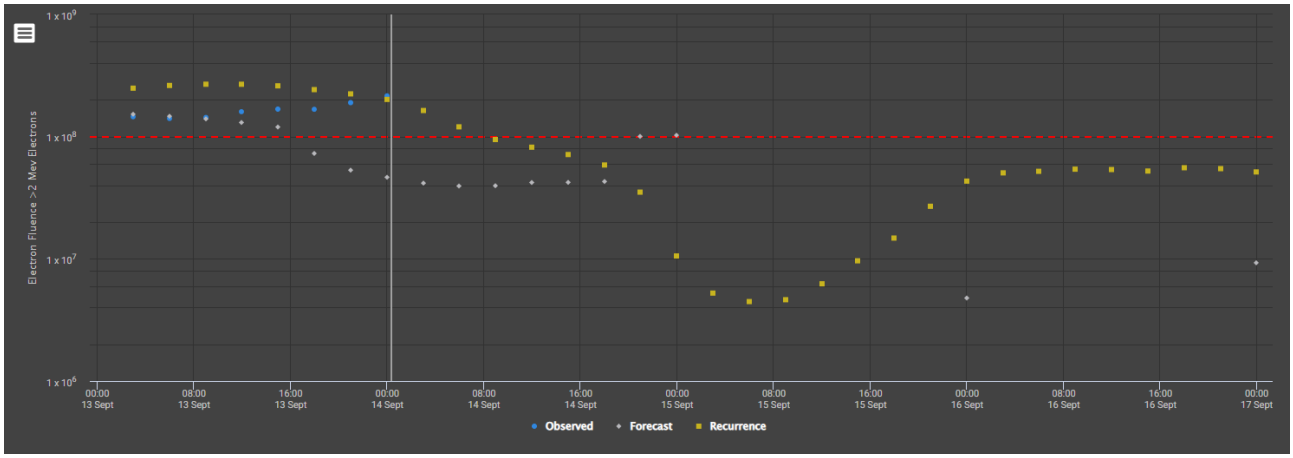
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux has varied between moderate and high levels through the last 24 hours. Otherwise, the diurnal peaks are expected to continue falling as the radiation in the belts slowly dissipate as the solar wind eases. A potential CME arrival on 14th September may lead to further losses due to geomagnetic enhancements, with a chance of a subsequent increase due to the injection of CME particles into the belts. A further variable is the possible arrival of CH23/- on 16th September, leading to another possible electron count reduction.

Electron fluence values are expected to follow a declining trend through the next four days, with low confidence toward the end of the period due to possible geomagnetic activity from CMEs and Coronal Hole HSS.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	50	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: REFM showing electron fluence observations, forecast and recurrance.



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